



# FRASER FIR SCOUTING MANUAL

This publication provides basic information on scouting primarily Fraser fir Christmas trees in western North Carolina. Sections of individual pests as well as more photographs are linked to individual pests on the pest control website ([christmastrees.ces.ncsu.edu/pest-control](http://christmastrees.ces.ncsu.edu/pest-control)).

**NC STATE**

EXTENSION

# General Scouting Information

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## Introduction

Scouting is the cornerstone of any integrated pest management program. It's the only way to learn if pests are becoming a problem and require control measures – or if those measures are working. This manual provides a summary of scouting procedures for important pests of Fraser fir Christmas trees grown in western North Carolina.

**What makes a pest?** There are three basic types of pests in Christmas tree:

- **Lethal pests:** These pests reduce tree growth and have the potential to kill trees. Examples are white grubs, *Phytophthora* root rot, and balsam woolly adelgid. These pests should either be avoided or completely controlled whenever present.
- **Cosmetic pests:** These pests seldom reduce tree growth, but they can reduce the commercial value of the tree by damaging its appearance. Examples are twig aphids that cause needle curl, mites that cause yellow foliage and premature needle drop, and rosette bud mites that kill developing buds resulting in uneven density. These pests typically only need to be controlled at certain times through the tree rotation.
- **Post-harvest pests:** These pests don't cause damage to the tree, but do reduce customer satisfaction. Some post-harvest pests are merely annoying to the end consumer such as Cinara aphids. Others are of regulatory concern when shipping trees to other states or countries such as certain species of scales.

## Scouting

**What is scouting?** Scouting is the process of actively looking for pests in order to make management decisions. To scout you need to make regular visits to a field. Only a few trees are examined closely to give an indication of the overall health of the entire block, field, or farm. Scouts should examine poorly growing trees, but also randomly selected healthy trees. The goal is to catch pest problems as they begin to develop but before they cause much damage to trees.

**Why scouting works.** Scouting doesn't have to be elaborate or time consuming, but it does have to be unbiased. That's because you are making decisions about all the trees and pests in the field by observing just a few. The way to be unbiased is to be random. That means that every tree and every branch on a tree has an equal and likely change of being selected and examined during scouting. These unbiased observations allow a scout to make assumptions about an entire field by examining just a few trees.



**It's not just bugs.** A scout looks for insect and mites that are pests but other things cause problems too like diseases, some weed, and nutritional issues. Any dead or dying trees should be examined as well as trees with poor color or stunted growth. Scouts will take soil samples or plant tissue samples as needed to determine fertility needs.

**It's more than just pests.** A scout should pay attention to more than pests and problems. It's important to monitor the growth of good groundcovers such as white clover and other woodland perennials. Scouts should be able to recognize and record the presence of insect predators or the evidence of parasitized scales. And before an insecticide treatment, a scout may need to assess if bees are foraging in groundcovers and could potentially be adversely affected.

**Scouting all ages of trees.** The emphasis of scouting changes through the rotation. The first couple of years after setting, groundcover management, fertility, and determining the cause of poorly growing or dying transplants are the main goals of scouting. As trees get bigger but still several years from harvest, the main goal is to track developing problems such as elongate hemlock scale, rosette bud mites, or even fertility problems. Trees to be harvested that year or the following year require more scouting to determine if cosmetic pests need to be controlled or if regulatory pests, which might restrict the sale of trees in some areas, are present.

**Scouting blocks.** A block is a scouting unit of trees planted at the same time and managed the same way at any given farm. It may comprise of a few hundred to a couple of thousand trees. It is best to break fields of several acres of the same-aged trees into smaller blocks for scouting purposes based on field roads. If blocks include mixed-aged trees, it is important to scout for pests in all sizes of trees.



**Field laid out in blocks can be scouted separately or as one large field**

**Walking the block.** Many pests scouted for are small and only found on a few plants out of hundreds. Therefore, it is important to cover the entire block while scouting and to take different paths through the block with each scouting trip. To accomplish this, you might want to walk the entire length of a set number of rows, or take a random walk circling through the field, or follow a zigzag pattern. Each time the block is scouted, take a different path.

For most pests, you will need to sample 10 to 20 trees per block. If farms of more than two acres are scouted as a single block (same age trees scouted the same way), increase the number of trees sampled.

Special consideration is needed in fields treated with mistblowers because of the potential of uneven spray coverage. Look at some trees near the spray road and some in the interior of the block and furthest away from the road. Take samples or make observations from the side of the tree closest to the sprayer and some from the side away from the sprayer. In fact, it's a good idea in any field to vary which side of the tree samples are taken from.

**Choosing trees to sample.** While scouting, look for trees with symptoms of pests or problems. This can include dead trees, dead branches, wilted shoots, trees with crooked tops, yellow or off-color foliage, or poor growth. Also sample trees showing no symptoms of pests or problems that are chosen at random. In this way, you can both diagnose problems and catch pests before they cause damage.

**Looking at shoots.** Remove smaller shoots (6 inches or less) of most current growth from the lower half of the tree as this is where most pests are found. Be sure to remove the entire shoot to where it attaches to the previous year's growth. Scan the shoot both front and back with a magnifying lens for pests and predators. This is the best way to find mites and twig aphid eggs.



**Looking at shoots**



**Taking foliage beats**



**Assessing the underside of foliage**

**Taking foliage beats.** Beat tree foliage over a plate or paper to dislodge pests and predators. Foliage beats are the best way to scout for twig aphids and predators as you are sampling multiple branches at once. Examine whatever falls out with a hand lens to make positive identifications. Many insects can fall out of trees, making it hard to know what's important and what isn't. For instance, thrips, springtails, and bark lice are insects that can often be found in high numbers on Christmas trees but do not cause tree damage or reduce pest numbers.

**Assessing the underside of foliage.** Because they live on the underside of foliage, one of the hardest pests to scout for are scales. Check trees with mottled foliage or that have a white cast to it due to the male elongate hemlock scale. But also check trees at random that show no outward sign of scales. Lift up branches, starting at the bottom of the tree and working your way to the top of the tree to determine if scales are present. Scales will also sometimes fall off onto beat plates when looking for other pests.

**Scouting from a vehicle.** If blocks and fields are large, it makes sense to scout from a vehicle. Many problems can be spotted while driving through a farm such as dead or discolored trees or trees with crooked tops. Nevertheless, it's important to get out and walk from farm roads into the interior of blocks to look for pests. On each scouting trip stop in different areas and walk through different groups of trees.

**Hot spot scouting.** Though most of the time when scouting, you want to make random observations and cover the entire field, it is also a good idea to mark problem areas to make further observations. The principle behind hot spot scouting is to make repeated visits to a few small and specific areas of the field that tend to have early or recurring pest problems. Hot spot scouting can also be used to determine the size and stage of weeds to time herbicide treatments, or to monitor the effects of weather on spider mite populations or foliar diseases. In some cases, such as scouting for rust mites, frequent trips over several weeks may be necessary as a pest problem develops. After an insecticide treatment, revisit the

hot spot to determine how well treatments worked. Identify the hot spot during the course of normal scouting and mark it with flagging and on a field map.

**Tools for scouting.** It takes only a few tools to scout, but all are important.

- Hand-held magnifying lens with 5X to 15X power
- Laminated paper, plastic plate, or something else to beat the foliage over
- Flagging to mark problem trees
- Plastic bags to keep samples of damaged shoots or insects that cannot be identified in the field
- Permeant marker to label flags and specimen bags
- Clippers for shoot and branch removal
- Pocketknife for removing shoots and bark samples
- Counter to keep track of the number of shoots sampled
- Cell phone to take photos, record GPS positioning, and find pest information on the internet
- Cell phone attachment to take photos of pests with magnification
- Coin to place beside pest specimen when taking photographs so that others know pest size
- Maps of fields to record problem areas
- Scouting sheets to record scouting results
- TIME. The only other tool needed for scouting is time. You have to make time to scout. It doesn't take long – but you have to do it consistently.

**The scouting calendar.** How frequently you need to scout depends on the pests that are in your area and the market you are producing trees for. Of course, you can observe pest problems any time you are working in your trees, but it is still important to have dedicated scouting trips to assess pests.

#### **January – March**

- Review scouting notes from previous year.
- Learn if gypsy moth, spotted lanternfly, and other pests of regulatory importance are currently found in your area.
- Get a jump on scouting by evaluating twig aphid eggs and spider mite eggs in go-to-market trees and do thorough scout for elongate hemlock scale in all fields as weather permits.

#### **April**

- Once twig aphid eggs have hatched, scout for aphids in go-to-market trees. While assessing twig aphids also:
  - Assess rust mite activity.
  - Observe when spider mites start to hatch and become active.
  - Take note of when predators are first observed.
- Determine the population and height of winter annuals and perennials. Determine the need for and timing of the first chemical mowing of the season.
- Assess activity of honeybees foraging in spring flowers such as mustard and purple deadnettle if trees are to be treated for twig aphids with pesticides having honey bee label restrictions.

## **May – June**

- Scout after twig aphid treatments to learn how well they worked. If considering retreating, also assess the presence of predators. If predators are found, retreatment may cause more harm than good.
- Assess the height of established groundcovers and Fraser fir bud swell to determine if a chemical mowing treatment would now be appropriate.
- If treated previously for elongate hemlock scale, determine if scales are moving onto new growth.
- In fields with Cryptomeria scale, start scouting for crawlers.

## **July – September**

- Assess trees for activity of male elongate hemlock scales causing white discoloration to foliage.
- Do thorough scouting for scale by lifting up branches to look at the underside of needles.
- Evaluate trees for balsam woolly adelgid by looking for crooked tops.
- In areas where rosette bud mites are a problem, evaluate incidence of damaged buds.
- Get a jump on scouting next spring by evaluating twig aphid eggs.
- Monitor for spider mites if weather is dry.
- Watch for late emerging annuals such as pigweed, barnyard and foxtail grasses. Also map location of problem weeds such as samplings, briars, and vines to be controlled once trees harden off.
- Dig holes to scout for white grubs in fields where seedlings will be planted.
- Take soil samples – ship to NCDA&CS before Thanksgiving to avoid processing costs.

## **October – November**

- Keep monitoring for spider mites if weather is dry.
- Scout for Cinara aphid in harvested trees.
- While harvesting brush and trees, check for incidence of scales in materials to be shipped to areas with concern for scales.
- Take plant tissue samples.
- Take soil samples – ship in to NCDA&CS before Thanksgiving.

## **Harvest**

- Teach crews to recognize Cinara aphids in trees.
- If shipping to areas with concern about scales or other post-harvest pests, monitor pest presence in tips and trees.

# Balsam Twig Aphids

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**Scientific name:** *Mindarus abietinus*

**Where from:** Native to North America

**Type of pest:** Cosmetic damage

**Pest description:**

- Twig aphids are green, but will vary from pale green, to an almost lime green, to dark green depending on how old they are and how recently they molted.
- Newly hatched aphids are very small and require a magnifying lens to see clearly. More mature aphids can be seen with the naked eye.
- Aphids may have a clear bead of honeydew at the end of their abdomen. More mature aphids have white filaments.
- By mid-May, aphids with wings are also found.
- Twig aphid eggs are small, black, and teardrop shaped. White, waxy rods are scattered across the surface of the egg. Sometimes the egg appears flat, and these may have been fed on by predators. Eggs get plumper when they are about to hatch in March. Eggs are present from June until they hatch in March and early April.



**Twig aphid egg on shoot**



**Twig aphid and caste skin**



**Needle curl**

**Damage to tree:**

- Twig aphid feeding as needles are expanding causes the needles to curl. Some of the damaged needles will straighten; other are damaged permanently.
- Aphid feeding does not damage already mature needles even though they feed on them.
- When numbers of twig aphids are high, sooty mold can develop on needles due to sugary substances in aphid honeydew.
- Twig aphids only feed on and damage true firs.

**Where found in the field:** Twig aphids are generally evenly distributed throughout the entire block of same-aged trees. However, if trees are treated with a mistblower, more aphids may be found where sprays do not reach.

**Where found on the tree:**

- Though twig aphids may be anywhere on the tree, focus on the most current growth. Twig aphids prefer the smaller shoots (2 to 4 inches) back in the canopy of the tree.
- Twig aphids can also be found on small, developing cones hiding under cone scales.
- Aphids may congregate around buds as they are swelling and about to break.
- After bud break, aphids are found in the developing shoots.
- Balsam twig aphid eggs are typically found on the stem of shoots of most current growth. They are found singly, but there may be several scattered on a single shoot.



**Balsam twig aphids in cone**

**Scouting method:**

- There is no relationship between tree damage last year and the number of aphids or potential for damage this year. That's because eggs are laid about a month after trees are damaged.
- **Scouting for eggs:** From July until March, randomly select small shoots and scan with a magnifying lens to find eggs. Assess 15 to 25 shoots per block.
- **Scouting for aphids before treating:** Scout for twig aphids after all the eggs have hatched (typically the first or second week of April) until bud break. Beat foliage over a plate to dislodge aphids. Use a magnifying lens to see smallest aphids. Sample from 10 to 15 trees per block. Keep track of number of aphids and predators found. If no or few aphids are found, check again in a couple of weeks as twig aphids are multiplying rapidly.
- **Scouting after treatment:** Assess insecticide control the week after treating but before trees break bud by beating foliage as previously described.

**How weather affects:** Wet, cold weather causes aphids to move deeper into the tree canopy for protection, so it's best to wait until the next sunny day before scouting.

**How to develop treatment threshold:** Treatment is not necessary in trees that are two years or more from market. In trees nearing market, even a few aphids can mean damage since the aphids quickly reproduce. A good working threshold is if even a single aphid is found on two different trees in a block before bud break, then that block is at risk of sustaining twig aphid damage that will affect the trees' marketability if left untreated. After bud break, only treat if predators are not commonly found.

**What can be confused with pest/damage:**

- Twig aphid eggs are the same size as balsam woolly adelgid nymphs. However, adelgid nymphs have orderly rows of white waxy rods whereas with twig aphid eggs, they are randomly scattered at different angles across the entire surface of the egg.



- No other pest of Fraser fir looks like twig aphids but there are many green aphids that feed on groundcovers around trees. Sometimes these aphids also get knocked into the plate when foliage beats are taken. Typically these aphids have longer legs and antennae and are a brighter green, and therefore easily distinguishable from twig aphids. Cinara aphids can also fall out onto beat plates. These are larger than twig aphids and are brown or black.
- Wind and hail damage can twist Fraser fir shoots but the needles are typically still straight. Herbicide damage can also twist shoots as well as needles.

**Important natural enemies:**

- Look for predators when taking foliage beats. Leave flowering groundcovers around your trees to attract predators as all of the twig aphid predators require pollen and nectar to thrive.
- Hover fly larvae – may also find hover fly eggs on shoots.
- Lady beetles and their larvae – may also find lady beetle egg clusters and pupae on shoots.
- Lacewing larvae – may also find lacewing eggs on shoots.



**Twig aphids in shoot. Notice cast skins from molting**

# Cinara Aphids

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**Scientific name:** *Cinara* species

**Where from:** Native to North America

**Type of pest:** Issue with marketing/reduces customer satisfaction

**Pest description:**

- On Fraser fir: *Cinara* aphids are large, dark aphids. They may be brown or black. They live in colonies on the trunk or branches.
- On white pine: the white pine aphids, *Cinara strobe* – is black with white markings and lighter colored legs. They can be found singly or in small clusters on shoots.
- Some *Cinara* aphids have wings.
- *Cinara* aphid eggs are rarely produced. They are oblong, black, and found on needles. There are typically several found in a loosely grouped together on several adjoining needles.



**Cinara aphids on Fraser fir**



**Cinara aphids on white pines**



**Cinara aphid eggs**

**Damage to tree:** *Cinara* aphids seldom damage trees. In droughty springs, terminal growth may be reduced. When present during the winter, white, crusty sap flows can sometimes be observed dripping from where aphids are feeding.

**Where found in the field:** *Cinara* aphids are found in scattered clusters of infested trees. When one infested tree is found, check surrounding trees.

**Where found on the tree:** *Cinara* aphids are typically associated with the terminal and first whorl of branches in the spring. In the fall, they are more common on the trunk or underside of branches lower in the canopy.

**Scouting method:**

- *Cinara* aphids can be found beating foliage over a plate while scouting for twig aphids.
- In the fall, do a general scout of the field. Look for hornet or yellow jacket activity in trees. Wasps are attracted to the sweet honeydew. Ants are as well. The flight pattern of hornets foraging for aphids is different than those returning to a hornet's nest in the tree, which is more direct.
- During harvest, make sure all workers can recognize *Cinara* aphids and report their presence.

**How weather affects:**

*Cinara* aphids are more of a problem in warm falls.

**What pest can be confused with pest:** *Cinara* aphids are often mistaken for ticks by the public. Ticks have eight legs at maturity and aphids have six.

**How often should trees be scouted:** Whenever working in trees, be on the lookout for *Cinara* aphids. Make a trip prior to harvest to look for *Cinara* aphids specifically.

**Treatment threshold:** If any *Cinara* aphids are found and the trees are to be harvested, they should be treated to prevent post-harvest pest problems.

**Important natural enemies:**

- Lady beetles and their larvae appear to be the most important natural control, though other general predators should also feed on *Cinara* aphids.



**Cinara aphids produce live young for most of their lifecycle**

# Balsam Woolly Adelgid

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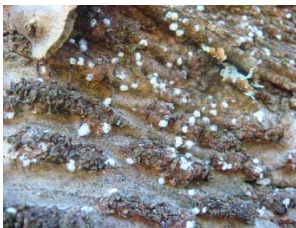
**Scientific name:** *Adelges piceae*

**Where from:** Introduced pest from Europe

**Type of pest:** Reduces growth because as the tree reacts to pest feeding by producing reaction wood that can eventually kill the tree.

**Pest description:**

- Adult stage can be seen with the naked eye as a white woolly covering. The wool protects a small, dark purple to black insect. Even though adults do not move, their six legs are still apparent under magnification. Often, there will be a dozen or more oblong, reddish-brown eggs behind the adult. All adults produced in North America are female and are found throughout the growing season, but not in the winter.
- Nymphs are small and require a magnifying lens to see. They are black with three rows of short, white rods along either side of the body and across the middle. Only the nymphs are found during the winter. They are also found throughout the rest of the year.
- Crawlers are occasionally found from April through October. They are the same color as the eggs with tiny black pin-points for eyes. They find a place on the tree to feed, and then settle into place, never moving again.



**Adult balsam woolly adelgids covered with wool**



**Balsam woolly adelgid nymphs on bud**



**Close-up of nymphs and a crawler**

**Tree damage:**

- Often the first symptom that the tree has balsam woolly adelgid is a stunted terminal growing at an angle. This is the easiest symptom for the scout to find. Healthy tops should be straight after the new growth hardens off in July.
- Gouting is another symptom of balsam woolly adelgid feeding. The tissue around buds is swollen as well as where the shoot attaches to the branch.
- Shorter, weaker, and/or drooping new growth over most of the tree.
- Stiff trunks and branches. Infested trees are stiff and harder to rock back and forth.
- Dead branches and dead trees.

- The wood in the trunk is hard, brittle, and is reddish-brown instead of cream-colored. When the tree is cut down, this hard brittle wood is easily seen and felt as the tree is harder to saw through.
- Balsam woolly adelgids are only pests of true firs. Fraser fir is one of the most susceptible species.



**Tree with crooked top**



**Red reaction wood from balsam woolly adelgid feeding**



**Gouting due to balsam woolly adelgid**

**Where found in the field:** Balsam woolly adelgid typically starts near infested fir trees from natural stands, abandoned Christmas trees, yard trees or other untreated trees. Trees on ridges may be exposed first as crawlers are blown in.

**Where found on the tree:** Balsam woolly adelgid can be found on tree buds and branches but are easiest to find on the trunk of the tree. They especially congregate under the branch/trunk union in the folds of the bark.

**Scouting method:**

- Teach shearing and tagging crews the symptoms of balsam woolly adelgid and have them mark problem trees.
- Examine closely any tree with a crooked top or dead branches. Push on the trunk of these trees at 4 to 5 feet off the ground to see if the trunk is stiff. Look on the tree trunk and branches to find the white wool of the adult female. The entire trunk should be examined with special attention to where the branch joins the trunk. To confirm the presence of the insect, remove any bark with white wool on it with a pocketknife and look at it with a magnifying lens.

- Scouting during the winter when adults aren't present is harder. Look at shoots exhibiting gouting for the nymphs. These infested buds often appear to point downward.
- Flag heavily infested trees before treating. Wait at least one month following treatment to assess control. Rub your finger over white woolly masses to see if they are dead. If still alive, the smeared bodies of the insects will leave a purple stain. Bark samples can also be removed containing adelgids and examined under a microscope to determine if they are alive.



**How weather affects:** If it is dry and the trees are suffering from drought the trees are more likely to show symptoms such as dead branches and wilting.

**How to develop treatment threshold:** Any balsam woolly adelgid infested tree needs to be treated before the next growing season (next spring).

**What can be confused with pest/damage:**

- Lichen or dried sap can appear white on trunks. Look carefully with a magnifying lens to distinguish the white wool of the insect.
- Twig aphid eggs are the same size as balsam woolly adelgid nymphs at first glance, but adelgid nymphs have white waxy rods lined up in rows whereas on twig aphid eggs, they are randomly scattered around the egg.
- Improperly sheared trees can mimic balsam woolly adelgid damage. In a tree where multiple leaders are left, the uppermost top may appear weak and grow at an angle. One way to tell the difference is that a healthy tree has good growth and the trunk is limber. Look for the insect on the trunk of the tree.

**Important natural predators:** Many predators will feed on balsam woolly adelgid including lady beetles and hover fly larvae. However, though these predators do feed on adelgids, they will not clean up the problem. Since Fraser fir is so sensitive to this pest, predators cannot be relied on to give control.

# Spruce Spider Mite

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**Scientific name:** *Oligonychus ununguis*

**Where from:** Native to North America

**Type of pest:** Cosmetic

**Pest description:**

- Spider mites are small and red to almost black in color. They have eight legs at maturity.
- Immature mites are smaller versions of the adults though with only three pairs of legs. While they are molting, they do not move and may appear dead.
- The eggs are small and round with a single hair coming out of the center. Only eggs are found in the winter.
- Occasionally spider mites will produce thin strands of webbing like a spider.

**Damage to tree:** Spider mites are a pest of most conifers. The spruce spider mite feeds by sticking its feeding tube into the needles. This causes tiny yellow spots to form on an otherwise green needle. When the damage is light, the spots will be at the base of the needle. As feeding progresses and damage becomes worse, the entire needle will have spots. Use a magnifying lens and flatten needles to see damage clearly. When damage is heavy, the whole needle appears yellow from a distance, but on closer inspection, the spots are still evident. Needles with heavy damage are more likely to drop off in the fall or after the tree is harvested.



**Spider mite damage**



**Female spider mite with eggs**



**Heavily infested shoot**

**Where found in field:**

- Spider mites are more of a problem at elevations lower than 3,000 feet in western North Carolina.
- Hotter and drier areas of the field such as south and southwestern exposures and ridge tops are more prone to spider mites.
- Spider mites are more of a problem along dusty roads as the dust that settles on needles kills predatory mites and not the more sedentary spider mite.

**Where found in the tree:** Look for spider mites on the most current growth. Spider mites are often found first on the bottom half of the tree.

### Scouting method:

- **Thorough scouting method specifically for mites:** Scout throughout the block, looking at a single shoot from 10 to 20 trees. Choose trees with yellow foliage as well as trees at random. Select a small shoot (2 to 4 inches) from the lower half of the tree and examine foliage both front and back for mites, eggs and damage. If the tree exhibits mite damage, choose this shoot from the damaged areas. Keep track of the number of shoots examined and shoots with either spider mite eggs or mites. At the same time, also scout for rust mites. Also take note if predatory mites or other predators are found.
- **In conjunction with twig aphid scouting:** While scouting for twig aphids by beating foliage over a plate, also check some trees for spider mites and rust mites by selecting small shoots and scanning them with a magnifying lens for mite activity.
- **Hot spot scouting:** Identify hot spots of mite activity early in the rotation and mark on map or with flagging. Check these areas in summer and fall during periods of hot, dry weather and low humidity.

**How weather affects:** Spider mites are more of a problem during warm, dry weather and low humidity. That is because wet weather slows mite egg hatch. Also, predatory mites prefer humid conditions.

### How to develop treatment threshold:

- Spider mite damage is seldom an issue in trees more than a year from harvest.
- In the past, treatment thresholds of between 10% to 40% of trees infested were used with the lower thresholds for trees nearer to market.
- Many miticides can only be applied once a year due to the possibility of resistance developing. Therefore, it's important not to overuse the same material. If mites are present but wetter weather is in the forecast or mite predators are present, delay treatment to allow natural controls a chance to work. Scout again in 1 to 2 weeks to determine if mite numbers are declining naturally.

**What can be confused with this pest/damage:** Yellow foliage can be caused by many things such as poor fertility and scale feeding. However, with closer inspection, spider mite feeding is the only thing that causes tiny, pinpoint size yellow spots on an otherwise green needle. Scale feeding causes yellow blotches in an otherwise green needle that resembles a camouflage pattern. Nutrient problems cause an overall yellowing of the needle.

### Important natural enemies:

- Predatory mites feed on spider mites. They are about the same size as spider mites but move much faster – running along the shoot or on a beat sheet. There are many species of predatory mite, ranging in color from reddish orange to tan.
- Lacewing larvae
- Minute pirate bugs
- Predaceous thrips
- During wet periods, spider mites may succumb to fungal pathogens. Their dead bodies will be covered by black fungus.



# Hemlock Rust Mite

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**Scientific name:** *Nalepella tsugifoliae*

**Where from:** Native to North America

**Type of pest:** Cosmetic

**Pest description:**

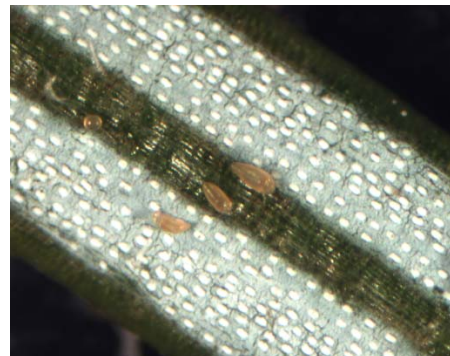
- Rust mites are smaller than spider mites and require magnification to see. There can be as many as 100 of these mites on a single needle. They are wedge-shaped and have four legs on the wider end. They can be clear, tan, cream, or orange-colored. They have four long hairs – two at their head and two at their tail.
- Rust mite eggs appear as tiny, clear balls typically in a group at the base of needles.

**Damage to tree:**

- Rust mite damaged needles appear bronze or rust-colored.
- In the spring, heavily damaged needles drop off the tree, leaving shoots from last year bare of needles and new growth emerging which may still be undamaged.
- Rust mites damage true firs, hemlocks and white pines. In white pine, damaged needles turn brown and are typically found in a round area in the upper third of the tree.



**Dozens of rust mites per needle causing bronzing**



**Close-up of rust mites**



**Defoliate from rust mites**

**Where found in field:** Rust mites distribution in the field is often scattered and reflects optimal environmental conditions for the mite.

**Where found in the tree:** Rust mites are found before the trees break bud on the newest growth. Once the trees start to grow, some mites move up onto the young tender growth. They are typically first found on the small shoots (2 to 4 inches) back in the canopy of the tree.

**Scouting method:**

- **Thorough scouting method specifically for mites:** In April, scout throughout the block, looking at a single shoot from 10 to 20 trees. Select a small shoot and examine foliage both front and back for mites. Keep track of the number of shoots examined and shoots with rust mites. In addition, keep track of the highest number of mites found on a single needle. At the end of scouting, you can calculate the percentage of trees with mites. The most mites found on a single needle is also important to determining if treatment is necessary.
- **In conjunction with twig aphid scouting:** While scouting for twig aphids by beating foliage over a plate, also check some trees for spider mites and rust mites by selecting small shoots and scanning them with a magnifying lens for mite activity.

**How weather affects:** Rust mites prefer spring-like temperatures. When weather warms especially at night, rust mite numbers decline naturally.

**How to develop treatment threshold:**

- It takes a lot of rust mites to cause much damage. However, if rust mites are present before bud break and trees will be treated for twig aphids, it may be wise to go ahead and use materials that will control both aphids and mites even if the treatment threshold hasn't been reached.
- For rust mites to cause damage, more than half the trees examined have to have rust mites (50% incidence) and in all the samples taken, there is at least one needle with more than 8 mites on it.

**What can be confused with this pest/damage:**

- In the spring when rust mites are active, there is a lot of pollen blowing around. Since rust mites are so small, they can be mistaken for pollen and dust. Using a magnifying lens, look for several seconds at an individual spot to see if it moves. With a good hand lens, you can also see the legs and hairs sticking up from the body.

**Important natural enemies:** Little is known about rust mite predators.

# Elongate Hemlock Scale

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**Scientific name:** *Fiorinia externa*

**Where from:** Introduced pest from Asia

**Type of pest:** Issue with marketing/regulatory action when shipping to areas where this pest is not found.

## Pest description:

- Crawlers are pale yellow and oblong and crawl on foliage. With a magnifying lens, the eyes can be seen as two tiny black dots. They also have tiny antennae. Crawlers settle on needles underneath the white wax covering back of the needle.
- Immature scales are yellow and oblong. The feeding tube is imbedded in the needle and, under magnification, can be seen as a thin, copper thread if the scale is flipped over on its top.
- Adult female scales are oblong and brown. The original yellow nymph is still found at one end. When half of a female scale is brown and the other half yellow, you are seeing the eggs inside the female scale.
- Immature male scales are oblong, white and produce white filaments to protect themselves. The body of the scale itself is orange with two large black spots where eyes are developing at the head.
- Adult males are a small, orange insect with long antennae and clear wings that fold over the top of their body. They have large black eyes. They have no mouthparts as they do not feed.



**Crawler settling under wax on the needle**



**Mottling due to scales**



**White filaments from the developing male elongate hemlock scale**



**Scales have moved to new growth in June**

### Damage to tree:

- Scale feeding can cause mottled foliage – yellow blotches on otherwise green needles in a pattern that resembles camouflage. However, scales can be present on needles without causing mottling.
- The white filaments produced by the immature males can be seen on the top of needles during periods of peak male production.
- In the southeastern US, elongate hemlock scale can be found on true firs, Douglas fir, hemlocks, Atlas cedar, and occasionally Mugo pine.



**Heavily infested branch with scales on multiple years of growth**

### Where found in field:

- Scale incidence in the field may be associated with infested hemlocks in field borders or near older Frasers that are infested with scales.
- Scale incidence is typically spotty initially. Gradually the majority of trees in a field can be infested.

### Where found in the tree:

- Found on underside of needles.
- Found on multiple years of growth, and therefore back in the canopy of the tree.
- More found lower on trees, but with heavy infestations, even the terminal may have scales.

### Scouting method:

- **Thorough scouting for elongate hemlock scale:** To follow scale progress in blocks through the rotation, each year scout for scales by examining at least 15 trees per block. Lift up branches, starting at the bottom and working your way to the top of the tree. Look at the underside of branches for scales examining needles that are one to three years old. Vary the side of the tree you examine as you walk through the field. Keep track of the number of trees examined and the number of trees with scale. Also take note of how severe the infestation is and if scales are on the most current growth.

- **Finding scale when scouting for twig aphids:** When beating foliage over a plate to look for twig aphids, also keep track if scales are found. Yellow scales that fall onto the plate are most likely developing male scales. They will have two large black spots where eyes are developing.
- **Finding scale when shearing/tagging:** Anyone who works in Christmas trees should know the basic symptoms of elongate hemlock scale which includes mottled foliage and white discoloration of the needles due to the male scale. They should either tag those trees for others to investigate, or look at the underside of needles for the scale itself.

#### How weather affects:

- Following winters with prolonged periods of bitter cold, scale populations appear to be reduced since nymphs don't survive well.
- Warm falls and winters promote the increase of scale incidence and spread in the field.

#### How to develop treatment threshold:

- When selling to markets with zero tolerance for scales, control must be near complete. Treating preventively through the rotation is required.
- For other markets, as long as trees are growing well and not discolored, there may be less need to control scale. However, before trees are cut, it may be necessary to treat them with an insecticide so the male scale doesn't become active and cause concern for the consumer once the tree is displayed at room temperatures.

#### What can be confused with this pest/damage:

- Algae on needles can be confused with the male scale. To distinguish, look for scales on the underside of needles.
- Other kinds of scales will cause mottling of foliage including *Cryptomeria* scale and pine needle scale. The presence of any of these may also cause regulatory action, but timing of controls are different, so be sure get a correct identification. Elongate hemlock scale is also much harder to control than these other scale pests.

#### Important natural enemies:

- Parasitic wasps, the primary one being *Encarsia citrina*, kill primarily female scales by laying an egg in them and consuming them as the wasp larva develops inside. A round hole can be found in scales that have been parasitized from the mature wasp leaving the scale. Examination under a microscope may reveal the developing wasp inside the scale.
- Dusty wings.
- Certain species of lacewing have been observed feeding on scales. These may take the filaments produced by the males and place them on their own backs for protection.
- Lady beetle adults and their larvae feed on scales. The most important species is the twice-stabbed lady beetles. In addition, small black lady beetles have been observed feeding on scales.



Holes where parasitic wasp emerged

# Cryptomeria scale

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**Scientific name:** *Aspidiotus cryptomeriae*

**Where from:** Introduced pest from Asia

**Type of pest:** *Cryptomeria* scale damages the tree through foliage discoloration and needle drop. It is also of regulatory concern.

**Pest description:**

- Immature and adult female *Cryptomeria* scales look like fried eggs – a yellow center surrounded by a white ring.
- As *Cryptomeria* scales mature, they may appear greyish.
- Adult male *Cryptomeria* scales are a small, orange insects with long antennae and clear wings that fold over the top of their body. They have large black eyes. They look like adult males of elongate hemlock scales.
- Adults female scales can be viewed by removing their protective covering. They are yellow and round with a nipple-like protrusion at one end. Multiple eggs may also be seen with the female.
- *Cryptomeria* scale crawlers are pale yellow and oblong and look like elongate hemlock scale crawlers.



**Cryptomeria scales on old and new growth**

**Damage to tree:**

- Scale feeding causes mottled needles – yellow blotches on green needles. This is a common symptom with *Cryptomeria* scale. This symptom is indistinguishable from the feeding of other species of scales.
- Scale feeding often causes needle shed. With *Cryptomeria* scale on Fraser fir, needle shed can be severe.
- *Cryptomeria* scales have been also found on dwarf Alberta spruce in western NC as well as other species of fir.

**Where found in field:** *Cryptomeria* scale incidence is typically spotty, and may even be limited to a few trees. When any are found, look at adjacent trees to determine the extent of the infestation.

**Where found in the tree:**

- Found on underside of needles.
- Found on multiple years of growth, and therefore back in the canopy of the tree.
- More scales are found lower on trees, but with heavy infestations, scales are found throughout the tree.

**Scouting method:**

- Any time mottled foliage is observed, look to identify what type of scale is causing it.
- If *Cryptomeria* scale is identified in one area of a farm or in a neighboring farm, scout for it in nearby blocks, fields, and farms.
- Scout by examining at least 15 trees per block for the scale. Start at the bottom of the tree and work upwards to look at all branches on that side. Lift up branches to see the underside of needles. Vary the side of the tree you examine as you walk through the field. Keep track of the number of trees examined and the number of trees with scale. Also take note of how severe the infestation is and if scales are on the most current growth.
- To time insecticide treatments, look for crawlers from June through August by examining needles with a magnifying lens from heavily infested trees. Look for the small, yellow crawlers moving on foliage.

**How to develop treatment threshold:** Treat for *Cryptomeria* scale any time it is found.

**What can be confused with this pest/damage:** Other kinds of scales will cause mottling of foliage including elongate hemlock scale and pine needle scale. The presence of any of these may cause regulatory action but *Cryptomeria* scale is by far the most damaging to the tree itself.

**Important natural enemies:**

- Twice stabbed lady beetles are very attracted to *Cryptomeria* scale. The presence of these predators is often the first clue that this scale is present.
- Parasitic wasps, the primary one being *Encarsia citrina*, kill scales by laying an egg in them and consuming them as the wasp larva develops inside. A round hole can be found in scales that have been parasitized from the mature wasp leaving the scale.

# White Grubs

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**Scientific name:** *Phyllophaga* and *Polyphylla* species

**Where from:** Native to North America

**Type of pest:** Kills young trees

**Pest description:**

- White grubs are the immature stage of scarab beetles. They live in the soil for up to 3 years before maturing into the adult beetle. White grubs have a white body with six legs and a dark head and usually lie in a curled or C-shaped position. Grubs of the same species will vary from very small to the size of your thumb depending on how old they are and the species.
- Not all grubs eat tree roots. White grubs are identified to species by looking at the raster pattern, which is the pattern of hairs at the tip of the abdomen. The raster pattern is easier to distinguish in older grubs.



**Small grubs found around tree roots**

**Damage to tree:** White grubs eat Fraser fir roots especially of young plants, leaving few feeder roots and stripping the bark off of main roots. This causes the tree to turn yellow and/or wilt, and eventually turn rust brown and die.



**Grub damage and root rot may have the same above ground symptoms**



**There are no fine feeder roots with grub damage**

**Where found in field:** The distribution of grubs in a field is typically spotty.

**Where found in the tree:** Found in the soil. They move deeper in the soil in the winter and are in the root zone during the growing season.



**Scouting method:**

- Look for grubs in areas where trees have died or in fields prior to planting. Evidence of animals such as skunks digging may also indicate grubs are present. Dig 2-3 holes in a block and sift through the soil to look for grubs.
- White grubs move deep into the soil during cold weather. Therefore, they may be hard to find in the early spring before soil temperatures warm. Some grubs will be pupating and molting to the adult beetle any time from May through August depending on the species. Then adult beetles will lay eggs and new grubs will appear in the soil in late summer. Therefore, it is best to scout for grubs in the early fall. However, you can get an idea of the grub population any time during the growing season. Just realize those numbers may increase.

**How weather affects:** As with *Phytophthora* root rot, tree symptoms of white grub feeding are more pronounced in hot, dry weather.

**How to develop treatment threshold:**

- If setting trees into pastures, assume grubs are present and treat transplant roots with an insecticide.
- After planting, treat for grubs if an average of more than one grub is found per hole examined.

**What can be confused with this pest/damage:**

- Many things can cause young trees to die, including *Phytophthora* root rot and other root diseases. Newly set trees may die because of poor storage and handling before setting, poor planting practices, or dry weather after planting. White grubs are the only pests that will eat off transplant roots. By digging in the soil around the plants, grubs can usually be found and identified.
- There is a white grub in the soil that does not feed on plant roots but rather on the thatch on the surface of the soil. This is the green June beetle grub. When laid on the ground, it will "crawl" on its back, not using its legs to move. These grubs come to the soil surface each night. If you apply a pesticide and see dead grubs on the ground the next day, you have only controlled the green June beetle grubs and not the grubs that are feeding on your roots.
- The black vine weevil grub looks somewhat similar to white grubs but has no legs. The black vine weevil has occasionally caused problems in seedbeds but not in field trees.
- The oriental beetle grub, *Anomala orientalis*, has also been identified feeding on roots of Fraser fir seedlings in lineout beds.

**Important natural enemies:** There are many predators and parasitoids of white grubs. One of particular importance in the mountains is the *Tiphia* wasp. This wasp feeds on flowering trees such as tulip poplar before laying eggs inside grubs in the soil.

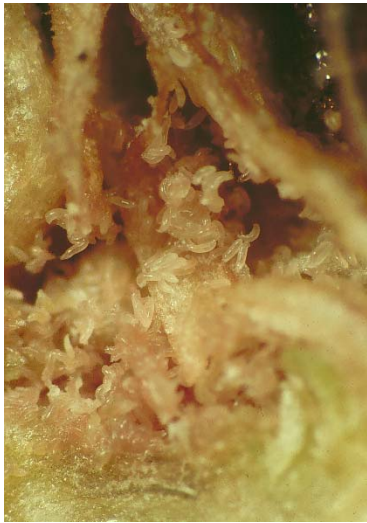
# Rosette Bud Mites

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**Scientific name:** *Trisetacus fraseri*

**Where from:** Native to North America

**Type of pest:** Cosmetic damage



**Rosette bud mites inside cavity**

**Pest description:** The rosette bud mite look almost exactly like hemlock rust mites. They live by the hundreds in cavities in affected buds. They are tiny, wedge-shaped with four legs on the wider end.

**Damage to tree:** Rosette buds are larger than normal and flattened instead of pointed in Fraser fir. They do not break and grow because there is a cavity inside instead of a tiny shoot. The resulting loss of buds causes uneven density, gaps, holes and weak bottoms. Good quality trees can still be grown but it will take 1-2 years more to fill the trees out properly.



**Where found in field:**

- Rosette buds are more likely to be found in protected fields where humidity stays higher.
- Fields at higher elevations have traditionally had more problems with rosette bud mites. Avery County has the greatest incidence of rosette bud mites as well as some areas of Jackson County or other high elevation farm locations.

**Where found in the tree:** Rosette bud mites are inside affected buds of Fraser fir. Rosette buds are more common in the lower half of the tree.

**Scouting method:**

- If rosette buds are found in your area, pay attention to bud development in the early part of the rotation to determine if blocks have rosette bud mite infested trees.

- **To determine need for treatment:** In trees more than two years from harvest, determine the percent incidence of trees having rosette buds. Do this by walking the entire length of two or more rows through a block to view at least 30 trees. Keep track of the total number of trees you walk past on one counter and the number of trees with rosette bud mites on another. It is only necessary to view trees from the direction you are walking. Divide the number of trees with rosette buds by the total number of trees examined to calculate the percent incidence.

**How weather affects:** The rosette bud mite moves from the old bud into the newly breaking shoots at bud break. They can survive this transition much easier when the weather is foggy or rainy. During dry springs, rosette bud mite incidence decreases.

**How to develop treatment threshold:** Treatment thresholds will vary depending on each grower's needs for quality and cost of treatment. A good working threshold is to treat trees more than 2 years from market if more than 10% of the trees have rosette buds as determined by the scouting protocol described above.

**What can be confused with this pest/damage:**

- Some individual trees produce larger buds than normal that can be mistaken for rosette bud mites. To distinguish these from rosette buds, slice the bud in half to reveal the cavity with mites in them. Healthy buds will have a green, triangular bud that will break and grow in the spring as well as well-organized bud scales surrounding it.
- Trees damaged by the balsam woolly adelgid may have buds with swelling at the base (gouting) that can also be mistaken for rosette buds. However, woolly adelgid trees will still have a green growing tip inside the bud. In buds affected by rosette bud mites, there is only a cavity and no growing tip.



Healthy Fraser fir bud cut in half

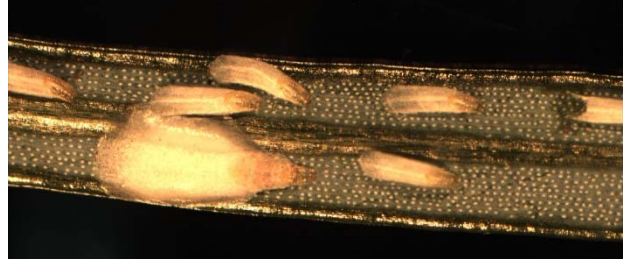
**Important natural enemies:** None known.

# Additional Pests to Recognize

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The following are some additional pests that you might find while scouting.

**Pine needle scale:** The pine needle scale is native to North America, but there are different species in different regions. These can only be distinguished by a trained entomologist. The presence of pine needles scales has resulted in regulatory scrutiny with plant materials sent to other states. Otherwise, this pest have never developed into a problem with Fraser fir Christmas tree production.



**Pine needle scale on Fraser fir**

## How to identify pine needle scale:

- Examine any shoots with mottling for scales on the underside of needles.
- Pine needle scales are long, white to greyish white with a yellow, pointed apex. They are distinguished from elongate hemlock scale because there are no brown scales and no filaments emerging from the white scales.
- Underneath the female scales there may be dozens of oblong, rosy-purple eggs.
- Crawlers are oval and light purple to reddish brown.

**Root aphids:** Root aphids feed on Fraser fir roots. They may be observed when lifting transplants or associated with young trees with stunted growth and poor color.

## How to identify root aphids:

- Root aphids are white to pale yellow. They are found on roots typically grouped together.
- Trees may exhibit symptoms of yellow needles and stunted growth.
- Ants may be found caring for root aphids. Ant galleries around roots may dry them out.



**Root aphids**

**Terminal feeders:** There are several kinds of pests that occasionally feed on the terminals of Fraser fir Christmas trees. Typically, only the damage is seen and not the pest itself. Pests include Pales weevils, Sawyer beetles, Japanese beetles, grasshoppers, and caterpillars such as *Campaea perlata* and *Elaphria versicolor*. In most cases, by the time damage is observed, there will be little further damage.



**Weevil on Fraser terminal**

**How to identify terminal feeders:**

- Observe irregular patches of damaged bark on terminals.
- It is hard to 'catch' these pests in the act of feeding. Some only feed at night, but may be found early in the morning or on cloudy days.
- Caterpillars, weevils, and beetles should be identified to species. If found, send to Plant Disease and Insect Clinic for positive identification.

**Bagworms:** Bagworms have a very wide host range but are usually associated with arborvitae or junipers. They are not common on Fraser fir. However, there have been a few Fraser fir Christmas tree fields where bagworm numbers have increased to the point that treatment was recommended.

**How to identify bagworms:**

- Green or brown bags resembling cones about 1 to 3 inches hanging from shoots. Caterpillars remain within protection of bags.
- Shoots defoliated of needles.

# Diseases

The following are some additional pests that you might find while scouting.

**Phytophthora root rot:** *Phytophthora* root rot is a disease of Fraser fir caused by a fungus that lives in the soil. The primary cause of the disease is the fungus, *Phytophthora cinnamomi*, but other species of *Phytophthora* have also been identified. These fungi attacks tree roots and grow up into the trunk of the tree. *Phytophthora* root rot is worse where the soil stays wet. Tree damage includes yellowing needles, wilting, dead branches, and tree death. *Phytophthora* root rot and white grubs cause similar looking damage to trees. Send samples to Plant Disease and Insect Clinic for confirmation of *Phytophthora*.

## How to identify *Phytophthora* root rot:

- Pattern of tree decline will follow water drainage through the field.
- Tree symptoms including foliage turning light green, wilted new growth, dead branches at the bottom of the tree, cankers on trunks near the base of the tree, and dead trees that are rust colored.
- Dead trees are easy to pull out of the ground.
- Dead roots and the outer portion of the root slips off of the inner core when pulled.
- No feeding evident in roots. Root system intact though dead and rotting.
- Cutting into the trunk reveals red-brown lesion under the bark running up the trunk of the tree from the roots.
- Fungi may be growing on the surface of the dead roots but these are secondary organisms. *Phytophthora* species are not visible to the naked eye.



**Trees dead from *Phytophthora* in lower lying areas of the field**



**Outer portion of root slips off of the inner core**

**Annosus root rot:** *Heterobasidion occidentale* is a soil fungus associated with several species of conifers. Spores infect freshly cut stumps. Infection spreads from stumps to roots of healthy seedlings or trees that contact infected wood. In North Carolina, issues are typically associated when white pines are cut near Christmas tree farms.



**Annosus root rot**

**How to identify Annosus root rot:**

- Tree symptoms include yellowing foliage and reduced growth though affected trees may not show any symptoms.
- The wood of infected trees may become rotted and stringy. Dark staining of older wood may be evident.
- Roots may exhibit decay.
- Fruiting bodies of the fungus may be found.

**Botrytis shoot blight:** *Botrytis* causes shoot death in the spring, usually in sites with high humidity and in springs with late frosts. Nothing can be done about *Botrytis* shoot blight in field-grown trees. Dead shoots usually fall off or removed during shearing. In greenhouse-grown seedlings, however, *Botrytis* can cause seedling blight that can be controlled with fungicides.



**Botrytis shoot blight**

**How to identify Botrytis:**

- Wilting and death of new growth.
- Lesion at the base of the shoot on new growth. Sometimes fungal spores and growth can be seen as a grey mold. This can help distinguish from frost injury.

**Fir/fern rust:** This rust disease alternates between firs and ferns – that is the spores produced on the ferns infect fir trees, and the spores produced on the fir trees infect the ferns. The fir/fern rust in western North Carolina is *Uredinopsis americana* (formerly called *Uredinopsis mirabilis*) which alternates between Fraser fir and sensitive fern. It is occasionally a problem along the edges of blocks of trees near woods where ferns are abundant.



**Fir/fir rust**

**How to identify fir/fern rusts:**

- Yellowing needles on newest growth, typically appearing in the summer. These needles may drop prematurely.
- White spores emerging from the underside of needles.
- Presence of ferns in neighboring woods also exhibiting fungal spores.

**Needle casts:** *Rhizosphaera pini*, similar to *Rhizosphaera kalkoffi* which causes a needle blight on Colorado blue spruce and other conifers, is not believed to be an aggressive pathogen of Fraser fir and may simply be sporulating on already dead needles.

**How to identify *Rhizosphaera* needle cast:**

- Red needles attached to stem. Premature needle shed.
- Black spores emerging from underside of needles in rows.
- Consult County Extension Agent to determine if further diagnostics are required to determine cause of problem.



*Rhizosphaera* needle cast

***Rosellinia* blight:** This infrequent disease is associated with large, dense trees with little air movement around them.

**How to identify *Rosellinia* blight:**

- Dead needles back in tree canopy.
- Mats of greyish fungus among needles. Round, dark grey fungal spore structures are also sometimes though not always observed.



*Rosellinia* blight

***Nectria* canker:** This infrequent disease caused the tops of trees to die back into the trunk of the tree.

**How to identify *Nectria* canker:**

- Trees dying from the terminal downward.
- Cankers in the trunk. Cracked bark. Red fungal spore structures forming on the bark.



Red fungal spore structures from *Nectria* canker



**Sooty mold:** Black fungal growth on needles and shoots due to the presence of honeydew produced by aphids or soft scales.

**How to identify sooty mold:**

- Black fungal growth can be wiped off of otherwise healthy, green needles.

**Algae:** Algae is often found growing on needles of trees grown in areas with little air movement where foliage doesn't dry out until late in the morning.

**How to identify algae:**

- Green to grayish discoloration on needles though current year's growth is not affected.
- Discoloration on the needle can be rubbed off of the needle surface to reveal the normal green needle underneath.



**Algae on the top of needles can be rubbed off**

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**Photo credits:**

**Jim Hamilton** – female spider mite with egg; **Travis Birdsell** – holes where parasitic wasps emerge

**Jill Sidebottom** – all others

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<https://christmastrees.ces.ncsu.edu/wp-content/uploads/2021/05/scouting-manual.pdf>

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